CLAIMS

What is claimed is:

1. A transparent multi-layer coating for a substrate, comprising:

a surface-hardening layer formed over the substrate;

a multi-layer abrasion-resistant coating formed over said surface-hardening layer; and

a hydrophobic dry coating formed over said multi-layer abrasion-resistant coating.

2. The coating of claim 1, wherein said abrasion-resistant coating comprises alternating layers of silicon dioxide and zirconium dioxide.

3. The coating of claim 2, wherein said abrasion-resistant coating sequentially comprises a silicon dioxide layer, a zirconium dioxide layer, a silicon dioxide layer, a zirconium dioxide layer, and a silicon dioxide layer.

4. The coating of claim 3, wherein said abrasion-resistant coating sequentially comprises a silicon dioxide layer of approximately 907 angstrom, a zirconium dioxide layer of approximately 765 angstrom, a silicon dioxide layer of approximately 174 angstrom, a zirconium dioxide layer of approximately 246 angstrom, and a silicon dioxide layer of approximately 2616 angstrom.

5. The coating of claim 1, wherein said hydrophobic coating comprises a perfluoroalkylsilane layer formed by a dry coating technique.

6. The coating of claim 5, wherein said perfluoroalkylsilane layer has a thickness of approximately 5-20 nm.

7. The coating of claim 1, wherein said hydrophobic coating and said multi-layer abrasion-resistant coating are both dry coatings formed by a vacuum coating technique.

8. The coating of claim 1, wherein said hydrophobic coating and said multi-layer abrasion-resistant coating have substantially equal thermal coefficients of expansion.

9. The coating of claim 1, wherein said surface-hardening layer is an organo-silicon polymer material.

10. The coating of claim 9, wherein organo-silicon polymer material is triethoxymethyl silane.

11. The coating of claim 9, wherein said organo-silicon coating has a thickness of approximately 2-3 microns.

12. The coating of claim 1, wherein said coating is formed on a glass substrate.

13. The coating of claim 1, wherein said coating is formed on a polymer-based substrate.

14. The coating of claim 1, wherein said coating is formed on an automotive window.

15. The coating of claim 1, wherein said coating is formed on an automotive mirror.

16. A method of forming a transparent multi-layer coating over a substrate comprising:

forming a surface-hardening layer over said substrate;

forming a multi-layer abrasion-resistant coating over said surface-hardening layer by sequentially depositing alternating layers of silicon dioxide and zirconium dioxide over said surface-hardening layer using a dry coating technique; and

depositing a hydrophobic coating over abrasion-resistant coating using a dry coating technique.

17. The method of claim 16, wherein said abrasion-resistant coating and said hydrophobic coating are dry coatings which are formed by a vacuum deposition technique.

18. The method of claim 16, wherein said abrasion-resistant coating is formed to sequentially comprise a silicon dioxide layer, a zirconium dioxide layer, a silicon dioxide layer, a zirconium dioxide layer, and a silicon dioxide layer.

19. The method of claim 18, wherein said abrasion-resistant coating is formed to sequentially comprise a silicon dioxide layer of approximately 907 angstrom, a zirconium dioxide layer of approximately 765 angstrom, a silicon dioxide layer of approximately 174 angstrom, a zirconium dioxide layer of approximately 246 angstrom, and a silicon dioxide layer of approximately 2616 angstrom.

20. The method of claim 16, wherein said hydrophobic coating comprises perfluoroalkylsilane.

21. The method of claim 20, wherein said perfluoroalkylsilane coating is formed to have a thickness of approximately 5-20 nm.

22. The method of claim 16, wherein said hydrophobic coating and said abrasion-resistant coating have substantially equal thermal coefficients of expansion.

23. The method of claim 16, wherein said surface-hardening layer is an organo-silicon polymer material.

24. The method of claim 23, wherein organo-silicon polymer material is triethoxymethyl silane.

25. The method of claim 23, wherein said organo-silicon layer is formed to have a thickness of approximately 2-3 microns.

26. The method of claim 1, wherein said coating is formed on a glass substrate.

27. The method of claim 1, wherein said coating is formed on a polymer-based substrate.

28. The coating of claim 1, wherein said coating is formed on an automotive window.

29. The coating of claim 1, wherein said coating is formed on an automotive mirror.